Australian Journal of Basic and Applied Sciences, 6(8): 597-604, 2012
ISSN 1991-8178

Effects of Humic Acid and Calcium Forms on Dry Weight and Nutrient Uptake of Maize Plant under Saline Condition

Wafaa H. Mohamed

Department of Soils and Agricultural Chemistry, Faculty of Agriculture Saba Basha, Alexandria University, Egypt.

Abstract: The aim of this study was to examine the effects of application of humic acid and calcium forms and there interaction on soil (PH, EC), dry weight, nutrients uptake of selected elements in maize (*Zea mays* L.) grown under salt stress. Four different doses of humic acid (0, 1.0, 2.0 and 3.0g kg^{-1}) and calcium forms [calcium sulphate ($CaSO_4$), calcium nitrate ($Ca(NO_3)_2$) and calcium chloride ($CaCl_2$)] were applied to the soil. Humic acids are an important soil component that can improve nutrient availability and impact on other important chemical, biological, and physical properties of soils. Application of humic acid and calcium forms significantly affected maize dry weight and nutrients uptake except Mn and Zn uptake. The salts at no humic acid applications caused plant death, but no plant death was obtained in humic application (1.0 and 2.0g kg^{-1}) doses in all of the salt type. The effects of salts in nutrient uptake were significant. Application of humic acid (1.0 and 2.0g kg^{-1}) doses and calcium sulphate ($CaSO_4$) increased dry weight and the N, P, K, Fe and Zn uptake of the maize plants. The soil pH was significantly decreased with application of humic acid. Also, the soil pH was significantly decreased with application of $CaSO_4$ compared with control. EC decrease significantly with application of humic acid (2.0 and 3.0g kg^{-1}) doses. On the other hand, EC value was increase significantly with application calcium forms.

Key words: humic acids; calcium forms; salt stress**;** nutrients uptake**;** maize.

INTRODUCTION

Salinity is a major a biotic stress, reducing the yield of wide variety of crops all over the world (Tester & Davenport, 2003 and Ashraf & Foolad, 2007). The genesis of saline soils may be natural or accelerated by excessive fertilization continuous cropping. The extension of irrigation in agricultural practices, and poor-quality water may also cause salinity problems with reduction in the yield and quality of product (Cansev and Ozgur, 2010). Soil salinity is characterized by high amounts of Na^{+}, Mg^{+2}, Ca^{+2}, Cl^{-}, HCO_3^{-}, SO_4^{-2}, and B ions which have negative effects on the plant growth. Plants growing in saline media come across generally with major drawbacks. The first is the increase in the osmotic stress due to high salt concentration of soil solution that decreases water potential of soil. The second is the increase in concentration of sodium (Na) and chloride (Cl), exhibiting tissue accumulation of Na and Cl, and inhibition of mineral nutrients uptake (Marschner, 1995). Eventually; high salt concentrations in the soil reduce the absorption of nutrients by plants which negatively affects the fertility of the soil. Thus, the agricultural areas that are affected by salt need amendments, such as a determination of the most suitable salt-tolerant plant species (Abrol *et al.*, 1988) or an alternative way is the use of high water holding capacity and organic - inorganic groups as a possible solution for conserving irrigation and rainwater in such arid and semi-arid region in order to reduce the effects of salinity (Masciandaro *et al.*, 2002; Bartels & Sunkar, 2005 and Yamaguchi & Blumwald, 2005). For overcoming the negative effect of salinity, the addition of supplemental organic matter (Walker and Bernal, 2004 and 2008), different source of nitrogen (Frechilla *et al.*, 2001) and calcium (Tuna *et al.*, 2007) to growth media as an ameliorative agent could be necessary. It has been reported by many researchers that calcium has a positive effects on increasing plant tolerance to salts in saline soils (Ehret *et al.*, 1990). Calcium is known to exert important consequences on several physiological processes in plants like ion transport, translocation of carbohydrates, protein and their storage during seed formation and other enzymatic activities. Calcium has been reported to inhibit Na^{+} uptake and thereby reduce its adverse effect on seed germination (Bonilla *et al.*, 2004 and Nayyar, 2003) as well as increase plant growth (Munns, 2002 and Tobe *et al.*, 2001). There was a competition between Na and Ca ions to enter into cell membrane. Therefore, it has been defended that higher calcium levels in soil protect cell membrane from negative effects of salinity (Busch, 1995). Several studies have evaluated the effect of the organic matter content on the fertility of soils (Loveland & Webb, 2003 and Pan *et al.,* 2009). The humic substances, the major component of soil organic matter, have both direct and indirect effects on plant growth (Sangeetha *et al.*, 2006). The direct effects are those that require the uptake of humic substances into the plant tissue resulting in various biochemical outcomes, whereas the indirect effects involve the improvement of soil

Corresponding Author: Wafaa H. Mohamed, Department of Soils and Agricultural Chemistry, Faculty of Agriculture Saba Basha, Alexandria University.
E-mail: islamonline73@yahoo.com

properties, such as aggregation, aeration, permeability, water holding capacity, micronutrient transport and availability (Tan, 2003). Masciandaro *et al.* (2002) found that using a soil seeded with maize in plant growth test, presented the best result when the mixture of saline solution–humic substances was used.

Little information on the effects of a Ca-HA treatment on plant growth and nutrient uptake of maize is available. Therefore, the present investigation was conducted to evaluate the forms of Ca with doses humic acid based on the dry weight, nutrient uptake assessments of maize plants and soil (pH and EC).

MATERIALS AND METHODS

The experimental soil has a Sandy clay texture and some of its physical and chemical characteristics were determined at beginning of the growing season before the applications of the humic acid and calcium forms. The analysis of soil was done according to the methods outlined in Page *et al.* (1982), and the data are shown in Table (1). Stress conditions were obtained by adding 60 Mm NaCl. Salt concentrations were initiated 45 days before the sowing time. Seeds were sown in pots. The seedling was thinned to three plants per pot. Before planting, Nitrogen at the rate of 100 mg kg^{-1} as NH_4NO_3, Phosphorus at the rate of 80 mg kg^{-1} and potassium at the rate of 100 mg kg^{-1} as KH_2PO_4 were applied to the pots. The experimental design was the split plot with three replicates. Three salt sources [$Ca(No_3)_2$, $CaSO_4$, and $CaCl_2$] were used distributed in the main plot, while doses of Humic acid treatments were distributed in the sup plots as follows (control, 1.0, 2.0 and 3.0g kg^{-1}). After 105 days of treatments, the plants were harvested (60 days in growth media), measured and analyzed. Samples of plant were oven dried at 65°C for 48 hrs, ground and stored for chemical analysis. Plant samples were wet digested by using $H_2SO_4.H_2O_2$ (Lowther, 1980) and the following determination were carried out in the digested solution: Total nitrogen was determined calorimetrically by Nessler method (Chapman and Pratt, 1961). Phosphorus was determined calorimetrically by vanadate molybdate yellow method (Chapman and Pratt, 1961). Potassium was determined by flame photometer according to Chapman and Pratt (1961). Fe, Mn, Zn and Cu were determined by using Atomic Absorption Spectrophotometer (Perkin Elmer-3300). Soil samples, representing all the studied treatments were taken at the harvest time, and chemical properties including pH and EC of soil were determined as illustrated by page *et al.*, (1982). All the recorded data were statistically analyzed using Costat software (Steel and Torrie, 1982).

Table1: Some chemical and physical properties of the soil studied.

Texture	Sandy clay	Exchangeable cations, meq 100g^{-1}	
Sand, %	45.14	Sodium (Na)	35. 7
Silt, %	15.24	Potassium (K)	167.4
Clay, %	39.62	Calcium (Ca)	89
pH	8.1	Magnesium (Mg)	275
EC, mS cm^{-1}	0.80	Available microelements, mg kg^{-1}	
CaCO3%	25.1	Iron (Fe)	5.53
Organic matter, %	0.60	Copper (Cu)	1.44
Total nitrogen (N), %	0.08	Zinc (Zn)	0.23
Available phosphorus(P),mg kg^{-1}	7.85	Manganese (Mn)	9.44

RESULTS AND DISCUSSION

Effects of humic acid and calcium form treatments on the growth, nutrients uptake, EC and pH of soil comparison of the means according to LSD test are given in Tables (2, 3 and 4).

Effects of Soil Application of Humic Acid:

The data in Table (2) showed that humic acid application significantly increased dry weight and this increase diminished with increasing humic acid doses compared with control. The highest mean of dry weights (3.57 and 3.72g) were obtained with doses (1.0 and 2.0g kg^{-1}) treatments. However, the differences between the effects of application of these doses (1.0 and 2.0g kg^{-1}) for dry weight were not significant. Generally, the relative increases with respect to the control were 1.16 and 1.25 % for (1.0 and 2.0 g kg^{-1}) humic doses. As mentioned above, one way the plant growth can be improved is through the structural improvement of sandy clay soil allowing for a better root growth development. Recent literature has shown that HA could be used as a growth regulator to regulate hormone levels, improve plant growth and enhance stress tolerance (Serenella *et al.*, 2002). Türkmen *et al.* (2004) similarly reported that 1000g kg-1 of HA application positively affected plant growth under saline soil conditions, but higher doses of HA inhibited plant growth.

Concerning the effect of doses humic acid on macro nutrients uptake in maize plants, the results have shown (Table 2) that, the application of doses of humic acid generally had positive effects and increased significantly, N and P nutrients uptake of the plants. Using (1.0g kg^{-1}) relative increases with respect to the control were 113.79 and 124.78% for N and P uptake, respectively. Such positive response might reflect, the humic acids are especially beneficial in freeing up nutrients in the soil so that they are made available to the plant as needed. Le Chang *et al.* (2012) reported that, the nitrogen in the leaves was remarkably enhanced by HA. For instance, if an aluminum molecule is bound with one of phosphorus; humic acids detach them making the phosphorus available for the plant. Humic can affect the solubility of insoluble phosphorus compounds in soil by its chelation capacity, and chelated metals are also available to plants by exchange (Tan, 2003). Result, also in Table (2) indicated that, K and Ca uptake were significantly increased by humic acid application as compared with control. The highest values were recorded for (2.0g kg^{-1}) HA dose.

Table 2: Dry weight and macro nutrients uptake of maize plants as affected by humic acid and calcium forms.

Calcium forms	humic doses (gkg^{-1})	Dry weight (g)	N-uptake	P- uptake	K-uptake	Ca-uptake	Na-uptake
			($g\ kg^{-1}$)				
0	0	2.08	151.91	66.55	366.59	66.42	3.75
	1	3.52	268.69	139.76	462.91	75.27	3.10
	2	4.96	297.28	94.84	491.66	68.95	3.25
	3	1.84	161.71	76.54	399.65	62.31	3.49
$CaSo_4$	0	2.0	195.19	62.39	388.15	85.39	3.11
	1	4.80	433.67	158.06	468.66	103.11	3.86
	2	4.64	328.31	122.29	503.16	110.70	6.18
	3	2.72	240.40	84.85	418.34	92.03	7.45
$Ca (No_3)_2$	0	1.60	165.79	50.75	345.02	80.65	4.21
	1	3.44	414.88	103.16	426.97	101.84	5.33
	2	3.84	383.85	103.16	457.16	108.17	7.11
	3	1.84	251.54	57.40	353.65	87.92	8.64
$Ca\ Cl_2$	0	0.80	66.97	18.30	301.89	75.90	4.31
	1	1.52	122.51	44.09	342.15	93.93	5.06
	2	1.44	135.51	39.10	313.40	100.58	7.32
	3	0.72	68.60	22.46	283.21	77.80	11.23
Mean effect of calcium forms							
0		3.10ab	219.89c	94.42b	430.20b	68.24d	3..39c
$CaSO_4$		3.54a	299.39b	106.90a	444.58a	97.81a	5.15b
$Ca (NO_3)_2$		2.94b	304.02a	78.62c	395.70c	94.65b	6.32a
$Ca\ Cl_2$		1.14c	98.41d	30.99d	310.16d	87.05c	6.98a
LSD		0.44	0.16	0.316	4.56	1.00	1.10
Mean effect of humic							
Humic	0	1.645b	144.97d	49.50d	350.41d	77.09d	3.85c
	1	3.57a	309.94a	111.27a	425.17b	93.54b	4.34c
	2	3.72a	286.25b	89.85b	441.35a	97.09a	5.97b
	3	1.78b	180.56c	60.31c	363.71c	80.02c	7.70a
LSD		0.44	0.11	0.17	3.78	0.83	1.28
Ca		**	**	**	**	**	**
Hu.		**	**	**	**	**	**
Interaction		**	**	**	**	**	*

*Significant at the 5% level; ** Significant at the 1% level and n.s: not Significant at P=0.05.

The Na^+ uptake by maize plants was found increased significantly by humic acid applications as compared with control. Since, Na uptake in the experiment derived mostly from the salt of NaCl in treatments (60 mM). Na^+ movement into root cells is passive (Valdrighi *et al.*, 1996). The increase of Na^+ may be related to humic acid causing greater root permeability by increasing lateral root development and total root bio-mass. Murat *et al.* (2011) conclude that, treatment of the soil with humus enhanced the uptake of nutrients in plant under conditions of 45 and 60 mM NaCl. Studies indicated that HA was in general not only beneficial growth but also nutrient uptake of vegetable crops (Dursun *et al.*, 2002 and Cimrin & Yilmaz, 2005). This is related to the surface activity of humic substances resulting from the presence of both hydrophilic and hydrophobic sites (Chen and Schnitzer, 1978). Therefore, the humic substances may interact with the phospholipid structures of the cell membranes and react as carriers of nutrients through them.

According the analysis of results, it is clear from (Table 3) that the addition of humic doses generally increased significantly, micro nutrients uptake except Mn and Zn uptake. The results indicated that, Fe uptake was increased significantly than control. The highest mean of Fe uptake (1.52 mg kg^{-1}) were obtained with doses (1.0 and 2.0g kg^{-1}) treatments, but there were no significant differences among these treatments. Lee and Bartlett (1976) found that, in maize roots, Fe^{3+} concentration was decreased after applying HA. In tomato plants grown in greenhouse conditions, applying humic acid increased the Fe^{3+} content in its roots (David *et al.*, 1994). Our results support this increase however, without any significant differences, related with the reduction from Fe^{3+} to Fe^{2+} and humic can chelate Fe^{3+} to change its form to be absorbed.

There appears to be no information relating to zinc accumulation in broad bean root. Despite it being stated that absorption is closely related with nutrient concentrations, particularly the presence of Ca^{2+} is of great importance. Contrary to this, in our experiment the Zn uptake has decreased while Ca^{2+} increased in HA treated plants. The Zn uptake decreased in HA treatment but did not show any significant differences from controls.

Some reports state that the antagonism between Fe^{3+}-Zn^{2+}, and Zn^{2+} interfered more with the absorption and translocation of Fe^{3+} rather than it did with Cu^{2+} and Mn^{2+}. On the other hand, Zn^{2+} decreasing in broad bean root may be related with the Fe^{3+} causing the absorption of Zn^{2+} and its toxicity (Olsen, 1972). Also, it is clear from (Table 3) that the addition of humic doses insignificantly effects on Mn uptake. The result is also seems to be related to the antagonistic effect of Ca^{2+} on Mn^{2+} uptake (Bozcuk, 2000).

Table 3: Micro nutrients uptake of maize plants as affected by humic acid and calcium forms.

Calcium forms	Humic doses ($gmkg^{-1}$)	Fe -uptake	Cu -uptake	Mn - uptake	Zn -uptake
		($gmkg^{-1}$)			
0	0	1.270	0.085	1.108	0.121
	1	1.360	0.089	1.283	0.138
	2	1.384	0.085	1.197	0.088
	3	1.449	0.090	1.193	0.115
$CaSo_4$	0	1.566	0.146	1.569	0.229
	1	1.676	0.176	1.861	0.209
	2	1.566	0.245	1.427	0.222
	3	1.657	0.190	1.613	0.213
$Ca(No_3)_2$	0	1.676	0.166	2.118	0.179
	1	1.730	0.168	2.323	0.202
	2	1.657	0.202	1.980	0.202
	3	1.566	0.180	2.140	0.194
$Ca Cl_2$	0	0.734	0.089	1.569	0.159
	1	1.347	0.214	1.512	0.156
	2	1.455	0.235	1.492	0.165
	3	1.250	0.175	1.579	0.161
Mean effect of calcium forms					
0		1.337b	0.087b	1.195c	0.116c
$CaSo_4$		1.616a	0.189a	1.610b	0.218a
$Ca(No_3)_2$		1.657a	0.179a	2.140a	0.194ab
$Ca Cl_2$		1.197c	0.178a	1.540b	0.160b
LSD		0.11	0.02	0.268	0.04
Mean effect of humic					
Humic acid	0	1.31b	0.121c	1.591a	0.172a
	1	1.52a	0.162b	1.747a	0.176a
	2	1.52a	0.192a	1.524a	0.169a
	3	1.45a	0.156b	1.631a	0.171a
LSD		0.09	0.01	0.19	0.02
Ca		**	**	**	**
Hu		**	**	**	**
Interaction		**	**	n.s	n.s

*Significant at the 5% level; ** Significant at the 1% level and n.s: not Significant at P=0.05.

Also, the results showed that, Cu-uptake of maize was found higher at all application doses of humus when compared with the control treatment, the highest Cu-uptake were obtained with 2 g humic /kg treatment. The initial adsorption rate values suggested that humic acid decreases the amount of Cu adsorbed as pH increase. Humic acids are especially important because of their ability to chelate micronutrients, thus increasing their bio-availability. The obtained results are supported by the previous outlined by (Apea & Ephralm, 2012 and Hussein & Hassan (2011). Asik *et al.* (2009) determined that under salt stress, the lowest doses of both soil and foliar application of humic substances increased the nutrient uptake of wheat.

In this study, higher dose of humic acid (3.0 g kg^{-1}) has less effect on dry weight and (macro and micro) nutrients uptake compared with other doses. This result might be related to the application levels. The application of very high doses of humic acids is less effective (Lee and Bartlett 1976). According to several researches, the results change due to the levels of treatment, growing media, and origin of humic substances (Arancon *et al.,* 2006).

Electric conductivity (EC) and pH of the soil treated with humic acid (HA) application was measured (Table 4), the EC value of the soil were lower in HA application doses compared to the non-treatment of HA. However, the effect of application of dose (1.0 gkg^{-1}) was not significant compared with control. The EC values of soil decreased significantly with doses (2.0 and 3.0 g kg^{-1}) treatments. This could be due to the role of humic acid in improving soil aggregation and water movement leaching the excessive soluble salts. These results agreed with that reported by Boyle *et al*., (1989). Regarding to the effects on soil pH, it is clear from Table (4) that the application of humic acid slightly reduce the soil pH.

Effects of Application of Calcium Forms on The Plant Growth and Nutrients Uptake:

Analysis of variance and mean of the studied characters are presented in Tables (2 and 3). The result showed that, dry weight was significantly influenced by the addition of three forms of calcium application. For evaluation the differences were obtained between forms calcium application and control, $CaSO_4$ gave the highest dry weight (3.54 g) compared with all treatments and control. Also, the results showed that, dry weight decreased for calcium nitrate (1.60 g) and more inhibited by $CaCl_2$ (0.80 g) at no HA application. Ameliorative effects of Ca $(NO_3)_2$ on plant growth were reported by the most researchers (Turkmen *et al.*, 2002 and Turkmen *et al.*, 2004**).** Statistical analysis indicated a significant effect of calcium forms on the nutrients uptake. For evaluations the effect of these forms on nutrient uptake, it is obviously show that significant differences were obtained between forms of calcium applied and control. Application of $CaSO_4$ and $Ca(NO_3)_2$ gave the highest N, K, Ca, Fe, Cu, Mn and Zn uptake in the plants. The highest decreases occurred in nutrients uptake of plant when, $CaCl_2$ was applied.

Salts $CaSO_4$ and Ca $(NO_3)_2$ increased the N uptake in maize plants by 36.15and 38.26%, respectively. Such increase occurred regardless the Ca^{2+} source in the growth medium. However, when $CaCl_2$ was used as the Ca^{2+} source, the N uptake decreased. These results agreed with that reported by Guimaraes *et al.* (2010).

Besides, little is known about the Ca^{2+} effects on P uptake and accumulation in salt-stressed plants. Regardless the sources effect, the $CaSO_4$ supplemented plants had a higher P and K uptake in plants in comparison to Ca $(NO_3)_2$ or $CaCl_2$ -supplemented plants. Such positive response might reflect to $CaSO_4$ as will have a contribution in decreasing soil pH (7.58) compared with all treatments and control (Table 4), this decreasing leading to increase P availability. The Ca uptake increased in the plants and was affected by the Ca forms in the growth medium. Supplemental Ca^{2+} provided as either $CaSO_4$, $Ca(NO_3)_2$ or $CaCl_2$ increased the Ca^{2+} uptake in maize plant. This phenomenon can be explained by the influx and translocation of Ca^{2+} to the shoot (Rengel, 1992).

The addition of 60 mM NaCl to the growth medium increased the Na^+ uptake in plants as might be expected, supplemental Ca^{2+} reversed the increased Na^+ uptake by plants. In addition, Ca^{2+} reduced the Na^+ translocation to the shoot and retained this ion in the roots (Kwon *et al.*, 2009). Nevertheless, this was not enough to alleviate the effects of NaCl on plant growth. (Farouk *et al.*, 2011) prove that, low sodium chloride salinity level, in general, enhanced the pea growth and yield as measured in, dry weights of leaves and stems, leaf area per plant. The Na uptake increased in plants and was affected by the Ca^{2+} source in the growth medium. Calcium sulfate treatments ameliorated Na-induced salinity in maize more than did comparable Ca $(NO_3)_2$ or $CaCl_2$ treatments.

Concerning the effect of different calcium forms on micro nutrients uptake in maize plants, the results have shown (Table 3), that $CaSO_4$ and $Ca(NO_3)_2$ proved to be more efficient than $CaCl_2$ in enhancing of the micronutrients uptake. These results are in agreement with the results outlined by (Marschner, 1995) who showed that, the increase of chloride (Cl), exhibiting tissue accumulation of Cl, and inhibition of mineral nutrients uptake

Regarding to the effects of calcium forms on soil Ec and pH, the result in Table (4) showed that, EC was significantly influenced by the addition of three forms of calcium application. For evaluations the effect of these forms on EC, it is obviously show that significant differences were obtained between forms of calcium applied and control, but there were no significant differences among these treatments. Statistical analysis indicated a significant effect of calcium forms on soil pH. For evaluation the differences were obtained between forms calcium application and control, $CaSO_4$ gave the highest decrease of soil pH (7.58) compared with all treatments and control. This decrease may be due to the acidity produced through SO_4. At neutral to high pH, humic acids are more negatively charged due to the ionization of COOH and phenolic OH groups. At low pH values, these functional groups are mostly protonated which makes humic acid less negatively charged and reduces intra molecular electrical repulsion (Braghetta *et al*., 1997).

Effects of Interaction Between Humic Acid and Ca Forms Treatment:

The effects of applications of humic doses and their interactions with calcium forms on dry weight and mineral nutrients uptake are presented in Tables (2 and 3).The results in Table (2) show that interaction between humic doses and Ca forms have a significant effect on dry weight. The highest value of dry weight (4.96 g pot^{-1}) was recorded under the application of 2.0 g humic kg^{-1}. Fusun *et al.* (2010) found that, applications of humic acid and calcium nitrate significantly increased dry leaf weight, dry root weight. The interaction effects of humic doses and ca forms proved that, a significant effect on N, P, K, Na, Fe and Cu uptake in the maize plants (Tables 2 and 3), and the highest of N, P and Fe uptake (433.67, 158.06 and 1.676 mg kg^{-1}), respectively were obtained in the treatment of 1.0 g humic kg^{-1} with $CaSO_4$. The highest of K and Cu uptake (503.16 and 0.245 mg kg^{-1}) was obtained in the treatment of 2.0 g humic kg^{-1} with $CaSO_4$ (Tab. 2). The highest of Na uptake was obtained in the treatment of 3.0 g humic kg^{-1} with $CaCl_2$. The effects of interactions on Mn and Zn nutrients uptake were not significant.

The interaction study of humic acid doses and calcium forms on soil EC or pH (Table 4) indicated that EC value in the soil was increased. This effect was clearly evident when EC were determined at $CaSO_4$ at non treatment of HA application. On the other hand, soil pH was insignificantly influenced by the interaction study of humic acid doses and calcium forms.

Table 4: The pH and EC of soil as affected by humic acid and calcium forms.

Calcium forms	Humus levels (gmkg[1])	EC (dSm[1])	pH
0	0	3.07	8.14
	1	3.27	8.07
	2	3.01	8.03
	3	2.67	7.95
$CaSo_4$	0	5.00	8.16
	1	4.72	7.66
	2	4.16	7.28
	3	3.86	7.22
$Ca\ (No_3)_2$	0	4.47	8.16
	1	4.24	8.03
	2	4.34	7.94
	3	3.43	7.47
$Ca\ Cl_2$	0	4.88	8.23
	1	4.60	8.21
	2	3.97	8.14
	3	3.64	8.00
Mean effect of calcium forms			
0		3.01b	8.05a
$CaSo_4$		4.43a	7.58b
$Ca\ (No_3)_2$		4.12a	7.90a
$Ca\ Cl_2$		4.27a	8.14a
LSD		0.37	0.19
Mean effect of humic			
Humic	0	4.36a	8.17a
	1	4.20a	7.99ab
	2	3.87b	7.85bc
	3	3.39c	7.65c
LSD		0.19	0.22
Ca		**	*
Hu		**	**
Interaction		*	n.s.

*Significant at the 5% level; ** Significant at the 1% level and n.s: not Significant at P=0.05.

Conclusion:

In conclusion, it was found that Ca sources and HA application concentrations were important for taking benefit from HA under salinity stress condition. The assessment of the effect of salinity on the growth parameters by different salt sources enabled the conclusion that 'all of the considered parameters were affected by salinity. In the presence of $CaCl_2$ salt concentration in the soil solution, plant growth parameters have higher decreasing rate than the SO_4 and NO_3 salts in the soil. This can be achieved to some extent by the application of HA soil amendments. Humic acid can ameliorate negative soil properties; improve the plant growth and nutrients uptake. They may be used in the case of the negative effect of salt that would inhibit the plant growth and nutrient elements uptake. Overall, we found out that the application doses are important for deriving benefit humic under salt conditions. Economical levels of application should be determined and should not exceed 2 g humus/kg in soil.

REFERENCES

Abrol, I.P., J.S.P. Yadav, F.I. Massuod, 1988. Salt effected soils and their management. Soil Resources, Management and Conservation Service, FAO Land and Water Develeopment Division, FAO Soils Bulletion, 39, Rome.

Apea, O.B. and J.H. Ephralm, 2012. Effect of humic acid on the kinetics and mechanism of copper adsorption in soil-solution system .J.of applied sciences in Environmental animation, 7(2): 137-146

Arancon, N.Q., S.L. Edward and R. Byrne, 2006. Effects of humic acids from vermicomposts on plant growth. European Journal of Soil Biology, 42: 65-69.

Ashraf, M. and M.A. Foolad, 2007. Improving plant abiotic-stress resistance by exogenous application of osmoprotectants glycine, betaine and proline. Environ. Exp. Bot., 59: 206-216.

Asik, B.B., M.A. Turan, H. Celik and A.V. Katkat, 2009. Effects of humic substances on plant growth and mineral nutrients uptake of wheat (Triticum durum cv. Salihli) under conditions of salinity. Asian J. Crop Sci., 1: 87-95.

Bartels, D. and R. Sunkar, 2005. Drought and salt tolerance in plants. Crit. Rev. Plant Sci., 24: 23-58.

Bonilla, I., A. El-Hamadaoui and L. Bolano, 2004. Boron and calcium increase *Pisumsativum* seed germination and seedling development under salt stress. Plant and Soil, 267: 97-107.

Boyle, M., W.T. Frakenburger and L.H. Stolyz, 1989. The influence of organic matter on soil aggregation and water infiltration. Journal of Production Agriculture, 2: 290-29.

Bozcuk, S., 2000. Bitki fizyolojisi, Hacettepe Üniversitesi, Fen Edebiyat Fakültesi, Ankara, Türkiye 3. Baskı, Ankara.

Braghetta, A., F.A. DiGiano and W.P. Ball, 1997. Nanofiltration of natural organic matter.pH and ionic strength effects, J.Environ. Eng., 123(7): 628-641.

Busch, DS., 1995. Calcium regulation in plant cell and his role in signaling. Ann. Rev. Plant Physiol., 46: 95-102.

Cansev, A. and M. Ozgur, 2010. Grafting cucumber seedlings on *Cucurbita* spp.: Comparison of different grafting methods, scions and their performance. J. Food. Agric. Env., 8: 804-809.

Chapman, H.D. and P.F. Pratt, 1961. Methods of analysis for soil, plant and water. University of California, Division of Agricultural Sciences. Riverside California.

Chen, Y. and M. Schnitzer, 1978. Water surface tension of aqueous solutions of soil humic substances. Soil Science, 125: 7-15.

Cimrin, K.M. and I. Yilmaz, 2005. Humic acid applications to lettuce do not improve yield but do improve phosphorus availability. Acta Agriculturae Scandinavica, Section B, Soil and Plant Sci., 55: 58-63.

David, P.P., P.V. Nelson and D.C. Sanders, 1994. A humic acid improves growth of tomato seedling in solution culture. Journal of Plant Nutrition, 17: 173-184.

Dursun, A., I. Guvenc. and M. Turan, 2002. Effects of different levels of humic acid on seedling growth and macro and micronutrient contents of tomato and eggplant. Acta Agrobotanica, 56: 81-88.

Ehret, D.L., R.E. Remann, B.L. Harvey and A. Cpywnyk, 1990. Salinty-induced calcium deficiencies in wheat and barley. Plant Soil, 128: 143-151.

Farouk, S., A.M. Abo-EL-Kheer, M.T. Sakr and M.A. Khafagy, 2011. Osmoregulators or plant growth substances as a growth inducer for pea plants under salinity levels. International journal of Agronomy and Plant Production, 2(4): 168-180.

Frechilla, S., B. Lasa, L. Ibarretxe, C. Lamsfus and P. Aparicio-Tejo, 2001. Pea responses to saline stress is affected by the source of nitrogen nutrition (ammonium or nitrate). Plant. Growth. Regul., 35: 171-179.

Fusun, G., S. Ferit and B. Sibel, 2010. Effects of calcium nitrate and humic acid on pepper seedling growth under saline condition. Journal of Environmental Biology, 31(5): 873-876.

Guimarães, F.V.A., F. Claudivan, E.C. Marques, C. Abreu and B. Eduardo, B.F. Aquino, J.T. Prisco and E.G. Filho, 2012. Braz. J. Plant Physiol., 24(1): 9-18.

Hussein, K. and A.F. Hassan, 2011. Effect of different levels of humic acids on the nutrient content, plant growth, and soil properties under conditions of salinity. Soil and Water Res., 6(1): 21-29

Kwon, T.R., S.Z. Siddiqui and P.J.C. Harris, 2009. Effects of supplemental calcium on ion accumulation, transport and plant growth of salt sensitive *Brassica rapa* Landrace. J. Plant Nutr., 32: 644-667.

Le Chang, Yun Wu1, Wei-wei Xu1, Nikbakht1 A, Yi-ping Xia, 2012. Effects of calcium and humic acid treatment on the growth and nutrient uptake of Oriental lily. African Journal of Biotechnology, 11: 2218-2222.

Lee, Y.S. and R.J. Bartlett, 1976. Stimulation of plant growth by humic substances. Soil Science Society of America Journal, 40: 876-879.

Loveland, P. and J. Webb, 2003. Is there a critical level of organic matter in the agricultural soils of temperate regions: a review. Soil Tillage Res., 70: 1-18.

Lowther, J.R., 1980. Use of single H_2SO_4- H_2O_2 disgest for the analysis of *Pinus radiata*, needles. Commun. Soil Sci. Plant Analysis, 11: 175-188.

Marschner, H., 1995. Mineral Nutrition of Higher Plants (2nd. Edition) (p. 446). London, GB: Academic Press. Inc.

Masciandaro, G., B. Ceccanti, V. Ronchi, S. Benedicto and L. Howard, 2002. Humic substances to reduce salt effect on plant germination and growth. Commun. Soil. Sci. Plant. Anal., 33: 365-378.

Munns, R., 2002. Comparative physiology of salt and water stress, plant. Cell & Environment, 25: 239-250.

Murat, A.T., B.A. Barış, V.K. Ali and E. Hakan, 2011. The effects of soil-applied humic substances to the dry weight and mineral nutrient uptake of maize plants under soil salinity conditions. Not. Bot. Hort. Agrobot. Cluj., 39(1): 171-177.

Nayyar, H., 2003. Calcium as environmental sensor in plants. Current Science, 84: 7-10.

Olsen, S.R., 1972. Micronutrient interactions, in Micronutrients in Agriculture, Mortvedt, JJ, Giordano PM, Lindsay, W.L., Eds., Soil Science Society of America, Madison, W.I., pp: 243-264.

Page (Ed.), 1982. Methods of Soil Analysis. Part 2. Book series No. 9. American Soc. of Agron. And Soil Sci. Soc. Am. Madison, Wisconsin. U.S.A.

Pan, G., P. Smith and W. Pan, 2009. The role of soil organic matter in maintaining the productivity and yield stability of cereals in china. Agric. Ecosystems Environment, 129: 344-348.

Rengel, Z., 1992. The role of calcium in salt toxicity. Plant, Cell and Environ, 15: 625-632.

Sangeetha, M., P. Singaram and R.D. Devi, 2006. Effect of lignite humic acid and fertilizers on the yield of onion and nutrient availability. Proceedings of 18th World Congress of Soil Science July 9-15, Philadelphia, Pennsylvania, USA.

Serenella, N., D. Pizzeghelloa, A. Muscolob and A. Vianello, 2002. Physiological effects of humic substances on higher plants. Soil. Biol. Biochem, 34: 1527-1536.

Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics. 2^{nd} addition. MC. Grow. Hill, New York.

Tan, K.H., 2003. Humic Matter in Soil and Environment, Principles and Controversies. Marcel Dekker, Inc., Madison, New York.

Tester, M. and R. Davenport, 2003. Na^+ tolerance and Na^+ transport in higher plants. Annals of Botany, 91: 503-527.

Tobe, K., Q.L. Zhang, H. Shimizu and K. Omasa, 2001. Characteristics of seed germination in five non-halophytic Chinese desert shrub species. Journal of Arid environment, 47: 191-201.

Tuna, A.L., C. Kaya, M. Ashraf, H. Altunlu, I. Yokas and B. Yagmur, 2007. The effects of calcium sulphate on growth, membrane stability and nutrient uptake of tomato plants grown under salt stress. Environ. Exper. Bot., 59: 173-178.

Türkmen, O., A. Dursun, M. Turan and C. Erdinc, 2004. Calcium and humic acid affect seed germination, growth and nutrient content of tomato (Lycopersicon esculentum L.) seedlings under saline soil conditions. Acta Hort. Scandinavica B., 54: 168-174.

Turkmen, O., S. Sensoy, I. Erdal and T. Kabay, 2002. Tuz lu kosul larda domateste cikis ve fide gelisimi uzerine kalsiyum uygulamalarinin etk iler i Yuzuncu Yi l Univers ites i (Effects of calcium on the emergence and seedling growth of tomatoes grown in salty grown media condtitions. Yuzuncu Yil University). J. Agric. Sci., 12: 53-57.

Valdrighi, M.M., A. Pera, M. Agnolucci, S. Frassinetti, D. Lunardi and G. Valini., 1996. Effects of compostderived humic acids on vegetable biomass production and microbial growth within a plant (*Chichorium intybus*)-soil system: A comparative study, Agriculture, Ecosystems and Environment, 58: 133-144.

Walker, D.J. and M.P. Bernal, 2004. Plant mineral nutrition and growth in a saline Mediterranean soil amended with organic wastes. Commun. Soil Sci. Plant. Anal., 35: 2495-2514.

Walker, D.J. and M.P. Bernal, 2008. The effects of olive mill waste compost and poultry manure on the availability and plant uptake of nutrients in a highly saline soil. Bioresour. Technol., 99: 396-403.

Yamaguchi, T. and E. Blumwald, 2005. Developing salt-tolerant crop plants: challenges and opportunities. Trends Plant Sci., 10: 615-620.